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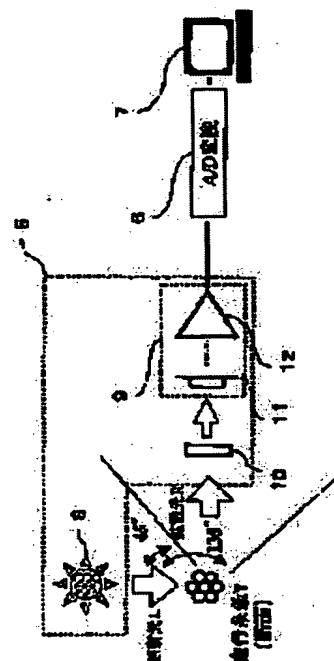
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TAKAMURA RYOJI(54) METHOD AND INSTRUMENT FOR MEASURING SHAPE CHARACTERISTICS OF
YARN AND MANUFACTURING METHOD FOR YARN

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a method and an instrument for yarn measurement which can automatically detect shape characteristics of a yarn and a manufacturing method for the yarn which is characterized by that quality control is performed according to the automatic detection result.

SOLUTION: The yarn Y which is running is irradiated with light L and a photodetecting means 5 photodetects diffused light from the traveling yarn Y within a range of 45 to 135° to the irradiation angle L; and shape characteristics corresponding to shape variation of the yarn are detected to perform the quality control.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the measuring device of the shape property of a line of thread, a measuring method, and the manufacture method of a line of thread. It is related with the measuring method which detects the shape property of a line of thread which consists of synthetic fibers, such as polyester and nylon, especially in detail, and the manufacture method of the line of thread characterized by controlling the quality of a line of thread based on a detection result further.

[0002]

[Description of the Prior Art] In the manufacturing process of a line of thread, when the tension change in a manufacturing process, heat treatment temperature change, wear of a false-twist twister, and a thread guide shift and abnormalities in a process, such as a confounding nozzle, i.e., a single-yarn piece etc., occur, the line of thread manufactured serves as poor thread, such as a fluff, a poor crimp, and a poor confounding occurring, or starting uneven dyeing at the time of dyeing and finishing. Since these poor thread is accompanied by configuration change of a line of thread, it measures configuration change of a line of thread off-line, and is controlling [whether poor thread is generated and] the quality.

[0003] As a measuring method of the line of thread which investigates configuration change of a line of thread in this way conventionally, and detects a fault, there is a method as shown in drawing 3 . This method performs tension control by the tension control circuit 18 so that it may be made to run by constant speed the sample thread 13 used as a subject of examination and may become fixed tension by the speed control circuit 15 using a tension gage 16 and the draw roller 17 using a feed roller 14 about it, and it makes a twist add to thread according to the twisting mechanism 19. In a test section 20, the light of a lamp 21 is floodlighted to thread, image formation of the image of the shadow of thread is carried out on a sensor 23 with a lens 22, and the outer diameter of thread is measured from the size of the image.

[0004] However, in this method of detection, speed and tension needed to be controlled uniformly, and in order to be stabilized and to measure run thread, the twisting mechanism needed to give the twist to the line of thread. Therefore, in order to be unable to attach into an actual manufacturing process but to conduct inspection by sampling from a shipment article, it could not inspect about all the shipment article, and the cause investigation at the time of fault generating was difficult, and the problem which is a manufacturing process that it could not respond promptly unusually had occurred.

[0005] Moreover, about confounding thread, it is detecting the intersection linkage coefficient per [which is called degree of confounding] unit length, and is inspecting whether the confounding has started normally. Although the filament which constitutes a line of thread from the former had measured the point which crosses mutually using CF value meter detected by the pricking method, since this method was also an inspection method by sampling, it could not inspect about all ****, and the cause investigation at the time of fault generating was difficult, and there was a problem which is a

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manufacturing process that it could not respond promptly unusually.

[0006]

[Problem(s) to be Solved by the Invention] The case of off-line inspection is to offer the manufacture method of the line of thread which can control the quality with the measuring method of the shape property of a line of thread which it is stabilized and can measure a shape property, of course also about the line of thread it is running in the manufacturing process of a line of thread, a measuring device, and the detected shape property, without giving a twist to the thread which is the measuring object, in order that the purpose of this invention may measure.

[0007]

[Means for Solving the Problem] The measuring method of the line of thread by this invention is based on the measurement means which installed irradiation light and the light-receiving means in the 1 flat surface which intersects (1) run line of thread. Irradiate light at a line of thread and the diffused light by the line of thread of the irradiated light is received in the range of 45 to 135 degrees to irradiation light. The measuring method of the shape property of the line of thread which detects the configuration profile according to configuration change of the longitudinal direction of a line of thread, and is characterized by determining the shape property evaluation value of a line of thread from the detected configuration profile from the diffused light which received light.

[0008] (2) The measuring method of the shape property of a line of thread given in the above (1) which determines the class mark of the evaluation according to configuration change of a line of thread from a configuration profile, chooses the portion used for evaluation out of a configuration profile based on this class mark, and is characterized by determining the shape property evaluation value of a line of thread from the selected portion.

[0009] (3) The measuring method of the shape property of a line of thread given in the above (2) which creates the frequency table of a configuration profile and is characterized by determining the class mark of the configuration profile according to configuration change of a line of thread from the created frequency table.

[0010] (4) The measuring method of the shape property of a line of thread the above (1) characterized by for a line of thread being confounding thread and the shape property evaluation value of a line of thread being the degree of confounding, or given in either of (3).

[0011] (5) The measuring method of the shape property of a line of thread the above (1) characterized by for a line of thread being partial-solution throwing, and the shape property evaluation value of a line of thread being a non-untwisting ratio or average sheep untwisting length, or given in either of (3).

[0012] (6) The measuring method of the shape property of a line of thread the above (1) characterized by a line of thread being partial extension thread, crimp thread, or piloerection thread, or given in either of (3).

[0013] Moreover, while the measuring device of the line of thread by this invention establishes a light-receiving means to receive irradiation light and the diffused light by the line of thread of the irradiated light in the range of 45 to 135 degrees to irradiation light, in the 1 flat surface which intersects (7) run line of thread A configuration profile detection means to detect the configuration profile according to configuration change of the longitudinal direction of a line of thread from the diffused light which furthermore received light, And the measuring device of the shape property of the line of thread characterized by having the shape property evaluation value determination means of the line of thread which determines the shape property evaluation value of a line of thread from the detected configuration profile.

[0014] (8) The measuring device of the shape property of a line of thread given in the above (7) characterized by having a determination means to determine the shape property evaluation value of a line of thread, from a selection means to choose the portion used for evaluation out of a configuration profile from a configuration profile based on a determination means to determine the class mark of the evaluation according to configuration change of a line of thread, and the determined this class mark, and the selected portion.

[0015] (9) The measuring device of the shape property of a line of thread given in the above (8)

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characterized by having a determination means to determine the class mark of the configuration profile according to configuration change of a line of thread, by creation means to create the frequency table of a configuration profile, and the created frequency table.

[0016] Moreover, the manufacture method of the line of thread by this invention is the manufacture method of (10) lines of thread, and is the manufacture method of the line of thread characterized by controlling the quality of a line of thread based on the shape property evaluation value determined from the shape property which detected and detected the shape property of the line of thread in a manufacturing process using the measuring method of the shape property of the line of thread of a publication at the above (1) or either of (6).

[0017] Namely, the manufacture method of the line of thread the above (10) Irradiate light at a line of thread and the diffused light by the line of thread of the irradiated light is received in the range of 45 to 135 degrees to irradiation light. The configuration profile according to configuration change of the longitudinal direction of a line of thread is detected from the diffused light which received light. Determine the shape property evaluation value of a line of thread from the detected configuration profile, and the manufacture method of the line of thread characterized by controlling the quality of a line of thread based on the determined shape property evaluation value is included. The shape property of partial-solution throwing and a line of thread to that a line of thread is [the shape property of confounding thread and a line of thread] the degree of confounding, and a pan Furthermore, a non-untwisting ratio or average sheep untwisting length, [a line of thread] Or it includes further that they are a non-untwisting ratio and average sheep untwisting length and that a line of thread is partial extension thread or piloerection thread.

[0018] According to this invention, light is irradiated to a line of thread and a shape property evaluation value can be detected based on the class mark of the evaluation which received the diffused light from a run line of thread in the range of 45 to 135 degrees to irradiation light, and determined and determined the class mark of the evaluation according to configuration change of a line of thread from the detection result of the diffused light which received light.

[0019] By the conventional measuring method shown in drawing 3 , since light was irradiated to a line of thread and the transparency diffused light was received from the line of thread, reflecting the 1 single yarn [which constitutes a line of thread / 1] state, the diffused light which receives light was not able to become unstable and was not able to detect the shape property of a line of thread by the state where a twist is not given. In this invention, one 1 single yarn which constitutes a line of thread since the diffused light was received in the range of 45 to 135 degrees to irradiation light emits gloss, and the shape property of a line of thread can be detected, without needing the policy for stabilization, such as giving a twist to a line of thread, since the diffused light stabilized over the whole path of a line of can be acquired. Therefore, it cannot be concerned with the kind of line of thread, and a measuring point, but the fault about configuration change of a line of thread can be detected automatically. Moreover, by using the measuring method or equipment of this line of thread for management of the manufacturing process of a line of thread, a manufacturing process can be rationalized and the manufacture method of the line of thread which aimed at improvement in yield can be offered.

[0020]

[Embodiments of the Invention] Drawing 1 is the schematic diagram showing an example of the manufacture method of the line of thread of this invention. Moreover, drawing 2 is the schematic diagram showing an example of the measuring device of a line of thread.

[0021] A measuring device is installed between the draw roller 3 and a drum 4 in the example of drawing 1 in the manufacturing process of a line of thread. Although the place of an in-process throat is sufficient as the installation of a test section 1, in order to check the final state in front of shipment, installing just before a drum 4 is desirable.

[0022] Moreover, as installation of a test section is shown in drawing 2 , irradiation light and a light-receiving means are established in the 1 flat surface which intersects a run line of thread. As preferably shown in drawing 2 , irradiation light and a light-receiving means are established in the 1 flat surface of the direction which intersects perpendicularly to the direction of a run line of thread. In the example of

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drawing 2 , to run thread Y, it is installed so that the irradiation light L and the light-receiving means 9 may become perpendicular. The above-mentioned light-receiving means receives the diffused light by the line of thread of the irradiated light in the range of 45 to 135 degrees to irradiation light. According to this installation condition, since the reflective diffused light in which it becomes detectable with the light-receiving means 9, and one 1 filament generates the reflective diffused light generated by the front face of the filament which constitutes run thread Y can be detected, light-receiving over the whole cross direction of run thread Y is attained, and gestalt change of run thread Y can be caught.

[0023] Thus, to the line of thread Y it is running in a production process, light is irradiated and light is received by the light-receiving means 9 from the light source 8 in the range of 45 to 135 degrees to the irradiation light L among the diffused lights R diffused in the run line of thread. In order to detect the shape property of thread with especially a crimp, it is desirable to receive the diffused light R of 90**10 degrees. Although especially the kind of light source 8 is not limited, an incandescent lamp, a halogen lamp, a xenon lamp, the high brightness Light Emitting Diode, etc. are used preferably. The light source 8 is installed in a black optical box, and irradiates a run line of thread. The diffused light by the run line of thread is received by the light-receiving means 9 through a slit 10 among the irradiated light L. Especially if the width of face of a slit 10 is sufficient width of face in order to detect the shape property of a line of thread, it will not be limited.

[0024] The light-receiving means 9 is constituted in the black optical box in which the slit 10 for letting the diffused light from a line of thread pass was formed. In the optical box, the photosensor 7 which senses the diffused light R is installed.

[0025] Moreover, the photo-electric-translation means consists of the photosensor 11, a current-potential conversion circuit 12, A/D converter 6, and a data processor 7. The quantity of light of the sensed diffused light R is changed into corresponding current, the current is transformed into voltage by the current-potential conversion circuit 12, further, after voltage is changed into digital data by A/D converter 6, data processing of the photosensor 11 is carried out by the data processor 9, and it outputs the shape property evaluation value of a line of thread.

[0026] Although the sensitization element which consists of a pyroelectric element, Sir mobile and the photoelectric tube, PbS, PbSe, etc. can be used as a photosensor 11, in order to detect the feeble light especially in a latus wavelength field with a sufficient precision, the element of photo diode is desirable. Also in it, silicon photo diode, germanium photo diode, and gallium arsenide photo diode are more desirable. Furthermore, that by which the electronic cooling element which can make small the influence and the thermal excitation noise of ambient-temperature change is included in the same package is desirable.

[0027] A photo-electric-translation means consists of a current-potential conversion circuit 12 which transforms into voltage the current outputted by the photosensor, A/D converter 2 which changes the voltage signal into a digital signal, and a data processor 7. The current-potential conversion circuit 12 has a desirable FET input type with few input bias currents as an operational amplifier for highly-precise-izing, in order to improve linearity of the voltage signal to light income. Moreover, the wiring which adds guard electrodes to the circumference of input single yarn, and prevents mixing of an unnecessary leakage current is desirable.

[0028] On the other hand, a current-potential sensing element has the desirable metal coat quantity resistance element of low noise nature by the degree coefficient of low temperature, and it is desirable to shield around and to reduce a guidance noise. As an A/D converter, in order to detect configuration change of a line of thread with a sufficient precision, a thing with a sampling frequency 10kHz or more is desirable.

[0029] The measurement operation by the measuring device of the line of thread mentioned above attaches a test section in the production process of a line of thread first. Light is irradiated to the line of thread Y it is running.

[0030] The diffused light is produced, the perpendicular component R passes along a slit 10 to an incident light among the diffused light, and the run line of thread Y which received the irradiation light L goes into the light-receiving means 9. The diffused light R which passed the slit 10 is sensed by the

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photosensor 11, serves as current corresponding to the quantity of light, and is outputted.

[0031] In the current-potential conversion circuit 12, after the outputted current is amplified, it is transformed into voltage and a voltage signal is transformed into it by digital data by A/D converter 6. The changed digital data is stored in a longitudinal direction in a data processor 7, and a configuration profile is created. The class mark of the evaluation of the created configuration profile of a line of thread to origin is determined, based on the determined class mark, the portion used for evaluation out of a configuration profile is chosen, and the shape property evaluation value of a line of thread is detected based on the selected portion.

[0032] The shape property evaluation value of this line of thread is detected by carrying out data processing based on the configuration profile which created the value by which A/D conversion was carried out in the voltage signal of the diffused light using the data processor 7. In the case of crimp thread, the property to detect is an outer-diameter value, in the case of confounding thread, it is the degree of confounding, and, in the case of partial-solution throwing, they are average sheep untwisting length and a non-untwisting ratio.

[0033] By moreover, the thing for which the fault judging of a line of thread is performed and a judgment result is fed back to the manufacturing process of a line of thread by the manufacturing process shown in drawing 1 based on the detected shape property evaluation value using the measuring method and equipment of a line of thread which were mentioned above. If it manufactures managing the manufacturing process of a line of thread, since the fault accompanying configuration change of a line of thread is automatically detectable, the manufacturing process of the line of thread which can realize laborsaving of the inspection in a product shipment process can be offered. Moreover, since the process used as the cause can be discovered and it can correct quickly from the shape property of the line of thread detected at the time of generating of poor thread, manufacture of a poor line of thread can be minimized and yield can be improved.

[0034]

[Example] Hereafter, based on an example, this invention is further explained to a detail.

[0035] In the equipment shown in drawing 2, the means of each part was set up as follows and the line of thread was measured.

[0036] As the light source, the Stanley high brightness Light Emitting Diode of brightness 3000mcd was used for the diameter of 5mm. The angle of irradiation light was made into the direction of normal N to the run line of thread, and the light-receiving angle was set as 90 degrees to Normal N. The size of a slit 10 was made into width of face of 1mm, and a length of 1mm.

[0037] The silicon phot sensor which has the light-receiving side of 6mm angle with a wavelength sensitivity of 200-1100nm was used for the photosensor 11.

[0038] Behind [this] a silicon phot sensor, the FET input type operational amplifier and the 100-M ohm metal film resistor for visible Mitsunari parts have been arranged, and the circumference was enclosed and shielded in the aluminum case to it. It is stabilized and could be made to carry out by carrying out like this photo electric translation of a part for feeble visible Mitsunari and the infrared light component which contain a required wavelength component respectively.

[0039] The output voltage signal of the diffused light was changed into the digital signal by 10kHz, using A/D converter 6 as a means of photo electric translation.

[0040] After performing initial setting of the [example 1] above-mentioned set point, the normal crimp thread it is running by part for 1000m/and which consists of a polyester multifilament line of thread of Tex and 36 filaments 167d, and crimp poor thread were measured, A/D conversion was performed by 10kHz, and the configuration profile was created. The configuration profile of crimp poor thread is shown in the configuration profile of crimp thread normal to drawing 4, and drawing 5. If the profile average is calculated from the result shown in drawing 4 and drawing 5, the average profile value of 6.16 and crimp poor thread will be set to 5.10 by the average profile value of normal crimp thread. Thus, if a crimp state changes, since an average profile value will also change, by detecting an average profile value change, it is automatic and inspection of a crimp state can be conducted.

[0041] After performing initial setting of the [example 2] above-mentioned set point, the confounding

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thread it is running by part for 1000m/and which consists of a polyester multifilament line of thread of Tex and 36 filaments 167d was measured, A/D conversion was performed by 10kHz, and the configuration profile was created. Drawing 6 shows the configuration profile at that time. The portion to which the profile value is high is the opening section, and the portion which is low is the confounding section. Frequency distribution were created based on the configuration profile shown in drawing 6.

[0042] The frequency distribution of the configuration profile created to drawing 7 are shown. In the frequency distribution of the configuration profile shown in drawing 7, the peak of two points generates confounding thread. The class mark of the confounding section and the peak of the higher one are detected for the peak of the method of a low of a profile value as a class mark of the opening section. The class mark of 6.2 and the opening section is set to 8.3 by the class mark of the confounding section in the example of drawing 7. Moreover, the profile value used as the minimum value in the field inserted into the peak of two points is detected as a class mark of the boundary of the opening section and the confounding section. In the example of drawing 7, the class mark of the boundary of the opening section and the confounding section is set to 7.4. Thus, from the configuration profile indicated to be the class mark of the boundary of the detected opening section and the confounding section to drawing 6, the confounding portion per unit length is counted and it detects as the number of confoundings. In the example shown in drawing 6, from 29 points and a bird clapper, the point which intersects the class mark 7.4 of the boundary of the opening section and the confounding section among a minute of 200mm configuration profiles can detect that there are the 29 confounding sections in 200mm, and can compute it as number of confoundings 145/m by converting this into the number per unit length.

[0043] Thus, the number of confoundings measured using CF value meter which is another process conventionally can be measured by detecting the number of confoundings, without conducting sampling inspection.

[0044] By the above method, conventionally, the number inspection of confoundings which was measuring by sampling inspection can be automated, and specification of the cause process at the time of fault generating also becomes certain.

[0045] Like the [example 3] examples 1 and 2, after performing initial setting, partial-solution throwing it is running by part for 600m/and which consists of a polyester multifilament line of thread of Tex and 36 filaments 167d was measured, A/D conversion was performed by 10kHz, and the configuration profile was created. Drawing 8 shows the configuration profile at that time.

[0046] A portion with a high profile value is the untwisting section, and a low portion is the non-untwisting section. Frequency distribution were created based on the obtained configuration profile. The frequency distribution of the configuration profile created to drawing 9 are shown. In the frequency distribution shown in drawing 9, the peak of two points occurs in partial-solution throwing. The class mark of the non-untwisting section and the peak of the higher one are detected for the peak of the method of a low of a profile value as a class mark of the untwisting section. In the example shown in drawing 9, the class mark of a non-untwisting portion is 8.7, and the class mark of the untwisting section is 9.8. Thus, the outer-diameter value of an untwisting portion and the class mark of the non-untwisting section are detected for the class mark of the detected untwisting section as an outer-diameter value of a non-untwisting portion. Moreover, the profile value used as the minimum value in the field inserted into the peak of two points is detected as a class mark of the boundary of the untwisting section and the non-untwisting section. In the example shown in drawing 9, the class mark of the boundary of the untwisting section and the non-untwisting section is 9.3. Moreover, from the class mark of the boundary of the untwisting section which carried out in this way and was detected, and the non-untwisting section, a configuration profile is divided into an untwisting portion and a non-untwisting portion, and the average sheep untwisting length who shows the length of an average of the non-untwisting ratio which shows the rate for which the non-untwisting portion in the whole line of thread accounts, and one non-untwisting portion is detected. In the example shown in drawing 8, when it dissociates with the class mark 9.3 of the boundary of the untwisting section which had a minute of 200mm configuration profile detected, and the non-untwisting section, the length of 136.9mm and a

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non-untwisting portion is computed for the length of an untwisting portion with 63.1mm, and average sheep untwisting length is computed for a non-untwisting ratio with 15.8mm 31.6%.

[0047] Thus, by using the outer-diameter value of the detected untwisting section, the outer-diameter value of the non-untwisting section, a non-untwisting ratio, and average sheep untwisting length, the fault detection accompanying configuration change of partial-solution throwing can be automated, and specification of the cause process at the time of fault generating also becomes certain.

[0048]

[Effect of the Invention] As mentioned above, according to this invention, light is irradiated to a line of thread, the configuration profile of a line of thread is created from the result which received the diffused light in the range of 45 - 135 degrees to the incident light, based on the created configuration profile, since the shape property evaluation value according to configuration change of a line of thread was calculated, it is automatic and fault detection accompanying configuration change of a line of thread can be performed. Moreover, by using the measuring method or equipment of this line of thread for management of the production process of a line of thread, a production process can be rationalized and the manufacture method of the line of thread which brings about the improvement in yield can be offered.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the schematic diagram showing an example of the manufacture method of the line of thread by this invention.

[Drawing 2] It is the schematic diagram showing an example of the measuring device of the line of thread by this invention.

[Drawing 3] It is the schematic diagram showing an example of the measuring device of the conventional line of thread.

[Drawing 4] It is the graph which shows an example of the configuration profile of the normal crimp thread by the measuring device of the line of thread of this invention.

[Drawing 5] It is the graph which shows an example of the configuration profile of the crimp poor thread by the measuring device of the line of thread of this invention.

[Drawing 6] It is the graph which shows an example of the configuration profile of the confounding thread by the measuring device of the line of thread of this invention.

[Drawing 7] It is the graph which shows the frequency distribution of the configuration profile of the number of confoundings by the measuring device of the line of thread of this invention.

[Drawing 8] It is the graph which shows an example of the configuration profile of partial-solution throwing by the measuring device of the line of thread of this invention.

[Drawing 9] It is the graph which shows the frequency distribution of the configuration profile of partial-solution throwing by the measuring device of the line of thread by this invention.

[Description of Notations]

- 1: Mouthpiece
- 2: Heater
- 3: Draw roller
- 4: Drum
- 5: Test section
- 6: A/D converter
- 7: Data processor
- 8: Light source
- 9: Light-receiving means
- 10: Slit
- 11: Photosensor
- 12: Current-potential conversion circuit
- 13: Measurement sample
- 14: Feed roller
- 15: Speed control circuit
- 16: Tension gage
- 17: Draw roller
- 18: Tension control circuit

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- 19: Twisting mechanism
- 20: Test section
- 21: Light source
- 22: Lens
- 23: Sensor
- 24: Amplifier
- 25: Ejector mechanism

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CLAIMS

[Claim(s)]

[Claim 1] It is based on the measurement means which installed irradiation light and the light-receiving means in the 1 flat surface which intersects a run line of thread. Irradiate light at a line of thread and the diffused light by the line of thread of the irradiated light is received in the range of 45 to 135 degrees to irradiation light. The measuring method of the shape property of the line of thread which detects the configuration profile according to configuration change of the longitudinal direction of a line of thread, and is characterized by determining the shape property evaluation value of a line of thread from the detected configuration profile from the diffused light which received light.

[Claim 2] The measuring method of the shape property of the line of thread according to claim 1 which determines the class mark of the evaluation according to configuration change of a line of thread from a configuration profile, chooses the portion used for evaluation out of a configuration profile based on this class mark, and is characterized by determining the shape property evaluation value of a line of thread from the selected portion.

[Claim 3] The measuring method of the shape property of the line of thread according to claim 2 which creates the frequency table of a configuration profile and is characterized by determining the class mark of the configuration profile according to configuration change of a line of thread from the created frequency table.

[Claim 4] The measuring method of the shape property of the line of thread according to claim 1 to 3 characterized by for a line of thread being confounding thread and the shape property evaluation value of a line of thread being the degree of confounding.

[Claim 5] The measuring method of the shape property of the line of thread according to claim 1 to 3 characterized by for a line of thread being partial-solution throwing, and the shape property evaluation value of a line of thread being a non-untwisting ratio or average sheep untwisting length.

[Claim 6] The measuring method of the shape property of the line of thread according to claim 1 to 3 characterized by a line of thread being partial extension thread, crimp thread, or piloerection thread.

[Claim 7] While establishing a light-receiving means to receive irradiation light and the diffused light by the line of thread of the irradiated light in the range of 45 to 135 degrees to irradiation light, in the 1 flat surface which intersects a run line of thread A configuration profile detection means to detect the configuration profile according to configuration change of the longitudinal direction of a line of thread from the diffused light which furthermore received light, And the measuring device of the shape property of the line of thread characterized by having the shape property evaluation value determination means of the line of thread which determines the shape property evaluation value of a line of thread from the detected configuration profile.

[Claim 8] The measuring device of the shape property of the line of thread according to claim 7 characterized by having a determination means to determine the shape property evaluation value of a line of thread, from a selection means to choose the portion used for evaluation out of a configuration profile from a configuration profile based on a determination means to determine the class mark of the evaluation according to configuration change of a line of thread, and the determined this class mark, and

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the selected portion.

[Claim 9] The measuring device of the shape property of the line of thread according to claim 8 characterized by having a determination means to determine the class mark of the configuration profile according to configuration change of a line of thread, by creation means to create the frequency table of a configuration profile, and the created frequency table.

[Claim 10] The manufacture method of the line of thread characterized by controlling the quality of a line of thread based on the shape property evaluation value which is the manufacture method of a line of thread and was determined from the shape property which detected and detected the shape property of the line of thread in a manufacturing process using the measuring method of the shape property of a line of thread according to claim 1 to 6.

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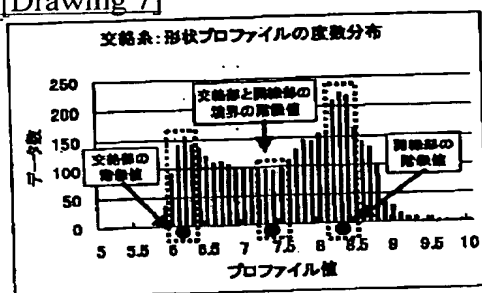
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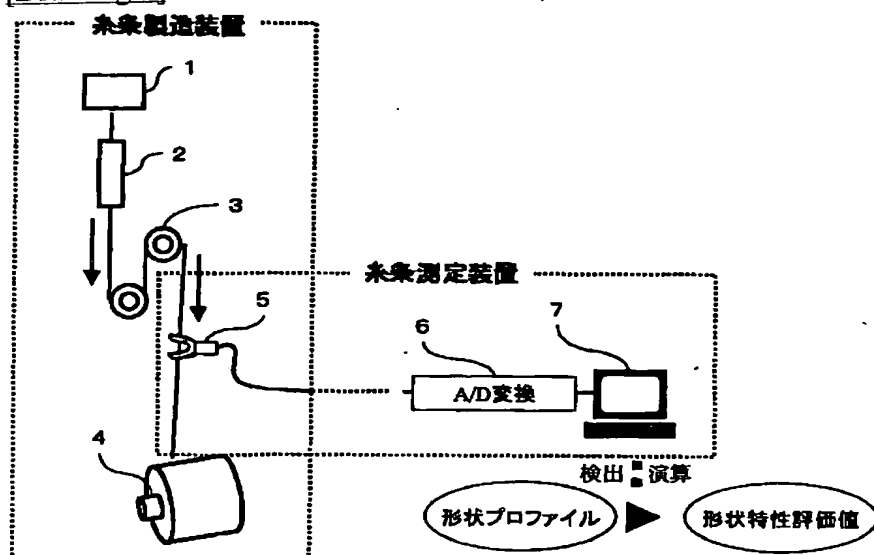
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DRAWINGS

[Drawing 7]

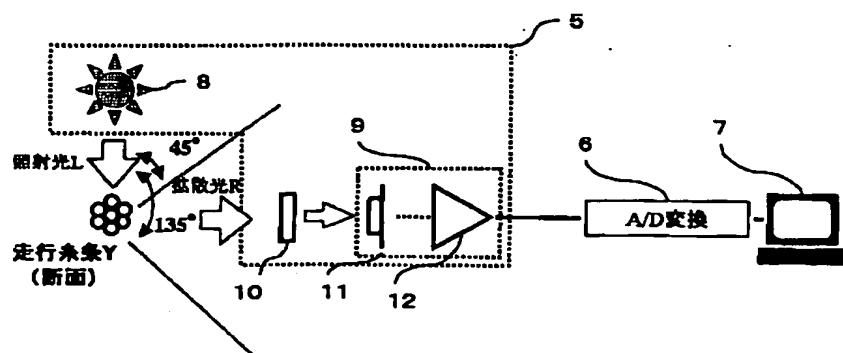


[Drawing 1]

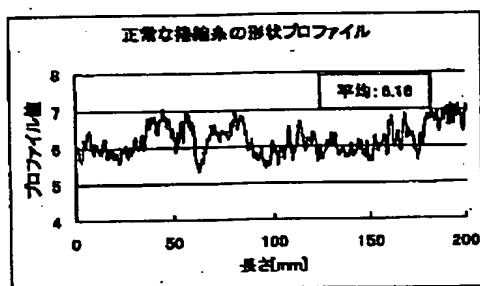


[Drawing 2]

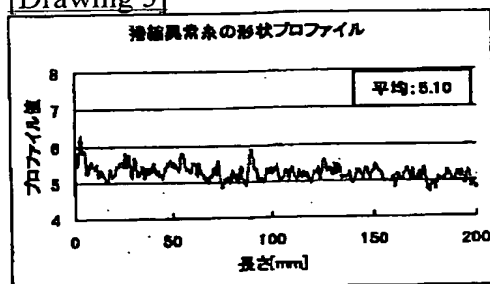
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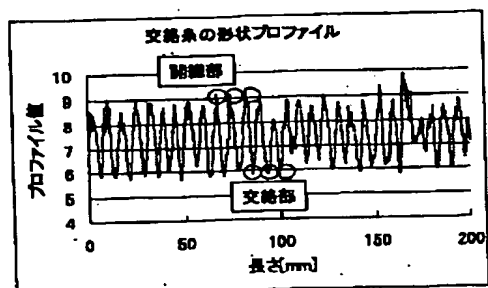
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[Drawing 5]



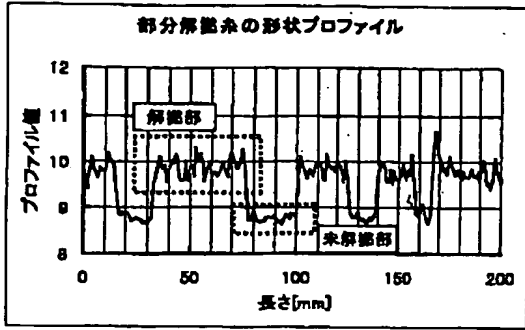
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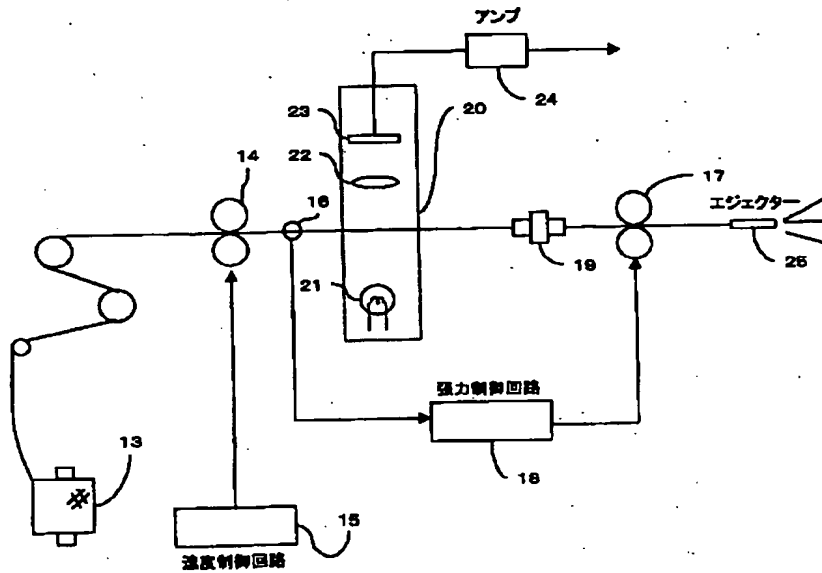
[Drawing 8]

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【図 8】

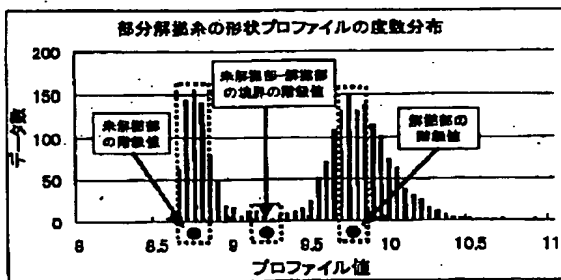


[Drawing 3]



[Drawing 9]

【図 9】



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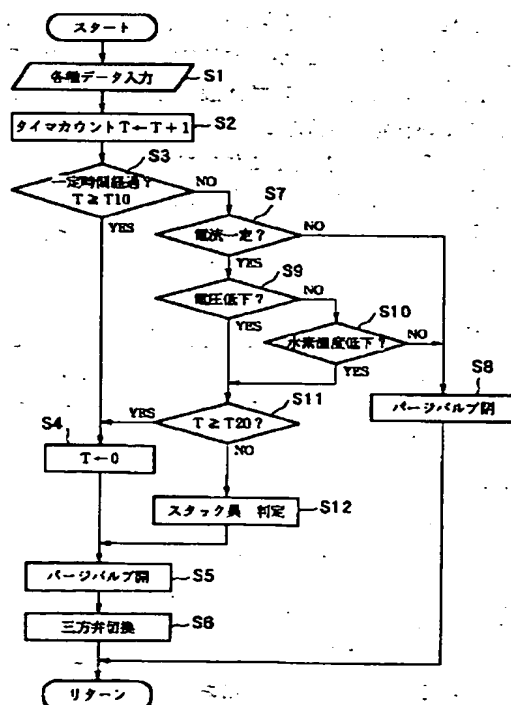
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(54) 【発明の名称】 燃料電池装置

(57) 【要約】

【課題】 ガス供給を行う循環経路内に不純物が混入することに起因する出力性能の低下を抑制できる燃料電池装置を提供する。

【解決手段】 各燃料電池スタック2に対して、水素給排系10を含む循環経路をもって水素を供給することを前提とする。水素給排系10にはパージバルブ41が設けられ、パージバルブ41は、各燃料電池スタック2の電圧低下或いは循環経路内の水素濃度の低下を検出して、開弁し、循環経路内の不純物を大気へ放出する。



【特許請求の範囲】

【請求項1】 第1ガスと第2ガスとを電気化学反応をさせて電力を得るセルと、該セルに対して、前記第1、第2ガスのうちの少なくとも一方のガスを循環供給する循環経路とが備えられる燃料電池装置において、前記循環経路に、電力発生状態が所定状態のとき該循環経路内の電力発生抑制物質を除去する除去手段が備えられている、ことを特徴とする燃料電池装置。

【請求項2】 請求項1において、前記所定状態が、前記循環経路内の電力発生抑制物質の量が所定値以上になることである、ことを特徴とする燃料電池装置。

【請求項3】 請求項1において、前記所定状態が、前記セルの電力発生度合が所定値以下である、ことを特徴とする燃料電池装置。

【請求項4】 請求項1において、前記除去手段が、電力発生状態が所定状態のとき前記循環経路内を大気に開放する大気開放弁である、ことを特徴とする燃料電池装置。

【請求項5】 請求項4において、前記循環経路に、電力発生状態が所定状態のとき前記第1、第2ガスのうちの少なくとも一方のガスを補充するガス補充装置が備えられている、ことを特徴とする燃料電池装置。

【請求項6】 請求項1において、前記除去手段が、電力発生状態が所定状態のとき前記電力発生抑制物質を吸着する吸着手段である、ことを特徴とする燃料電池装置。

【請求項7】 請求項6において、前記吸着手段が、前記循環経路に対して、該循環経路に付設されるバイパス通路を介して設けられ、該バイパス通路に、電力発生状態が所定状態のときに前記吸着手段への流れに切換える切換弁が設けられている、ことを特徴とする燃料電池装置。

【請求項8】 請求項1において、前記除去手段として、電力発生状態が所定状態のとき前記循環経路内を大気に開放する大気開放弁と、電力発生状態が所定状態のとき前記電力発生抑制物質を吸着する吸着手段とが備えられていると共に、前記循環経路に、電力発生状態が所定状態のとき前記第1、第2ガスのうちの少なくとも一方のガスを補充するガス補充装置が備えられている、ことを特徴とする燃料電池装置。

【請求項9】 請求項1において、前記第1、第2ガスのうちの一方のガスが水素であり、前記第1、第2ガスのうちの他方のガスが酸素含有ガスであり、前記セルに対して、前記循環経路をもって水素のみが循環供給される、ことを特徴とする燃料電池装置。

【請求項10】 請求項9において、

前記除去手段が、電力発生状態が所定状態のとき前記電力発生抑制物質を吸着する吸着手段であり、該吸着手段がパラジウム薄膜により構成されている、ことを特徴とする燃料電池装置。

【請求項11】 請求項1～10のいずれかにおいて、前記セルが、1以上のセルをもって構成されている、ことを特徴とする燃料電池装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、電力の発生を抑制する電力発生抑制物質を効果的に除去できる燃料電池装置に関する。

【0002】

【従来の技術】燃料が有する化学エネルギーを電気エネルギー（電力）として直接取り出すものとして、燃料電池装置が知られている。この燃料電池装置は、1以上のセル（燃料電池）をもって構成され、そのセルは、電解質膜を一对の電極で挟持し、その各電極の外側面に画成部材と協働してガス通路をそれぞれ形成することになっている。そして、一方の側のガス通路に第1ガス（例えば燃料ガス（具体的には水素等））を供給し、他方の側のガス通路に、第1ガスと電気化学反応を起こす第2ガス（例えば酸化ガス（具体的には空気））を供給することにより、その第1、第2ガスの電気化学反応に基づき一对の電極から電力を取り出せることになっている。

【0003】このような燃料電池装置は改良が加えられ、現在では、特開平10-83824号公報に示すように、燃料電池（セル）における電極がCOにより被毒され出力が低下したときに、燃料電池の温度を高めると共に反応ガスの水蒸気分圧を一定にして、出力性能の低下を抑えたものや、特開平7-272738号公報に示すように、燃料電池の停止時に、燃料ガスを窒素ガスと置換して、起電力の発生を早急に停止するものが提案されるに至っている。

【0004】ところで、本出願人は、燃料電池装置として、セルに対して、循環経路をもって前記第1、第2ガスのうちの少なくとも一方のガスを循環供給するものを既に提案している。このものにおいては、循環経路に基づき未使用のガスを再使用できることになり、ガスの有効利用を図ることができることになる。

【0005】

【発明が解決しようとする課題】しかし、最近の研究によれば、何等かの原因で循環経路内に電力発生抑制物質としての不純物（窒素、一酸化炭素、二酸化炭素、埃等）が入り込み、その不純物が、循環経路が閉サイクル故に徐々に蓄積され、その不純物が電極反応面に付着することが見い出されている。このため、そのことにより電気化学的反応が阻害され、出力性能が発電（運転）に伴い低下することになっている。

【0006】本発明は以上のような事情を勘案してなす

れたもので、その技術的課題は、ガス供給を行う循環経路内に不純物が混入することに起因する出力性能の低下を抑制できる燃料電池装置を提供することにある。

【0007】

【課題を解決するための手段】上記技術的課題を達成するために本発明（請求項1の発明）にあつては、第1ガスと第2ガスとを電気化学反応をさせて電力を得るセルと、該セルに対して、前記第1、第2ガスのうちの少なくとも一方のガスを循環供給する循環経路とが備えられる燃料電池装置において、前記循環経路に、電力発生状態が所定状態のとき該循環経路内の電力発生抑制物質を除去する除去手段が備えられている、ことを特徴とする燃料電池装置とした構成としてある。この請求項1の好ましい態様としては、請求項2以下の記載の通りとなる。

【0008】

【発明の効果】請求項1に記載された発明によれば、除去手段が、電力発生状態が所定状態のとき循環経路内の電力発生抑制物質を除去することになり、循環経路内の電力発生抑制物質の濃度は低減することになる。このため、電力発生に伴い、電力発生抑制物質に起因して出力が低下することを抑制できることになる。

【0009】請求項2に記載された発明によれば、所定状態が、循環経路内の電力発生抑制物質の量が所定値以上になることであることから、出力低下に影響を与える電力発生抑制物質の混入量を的確に捉えて、電力発生抑制物質を除去することになり、予め発生する出力の低下を前もって抑制できることになる。

【0010】請求項3に記載された発明によれば、所定状態が、セルの電力発生度合が所定値以下であることから、頻繁に電力発生抑制物質の除去作業を行うことを回避できることになる。

【0011】請求項4に記載された発明によれば、除去手段が、電力発生状態が所定状態のとき循環経路内を大気に開放する大気開放弁であることから、電力発生状態が所定状態のときに大気開放弁を開弁するだけで、循環経路内のガス圧を利用して電力発生抑制物質を大気に放出でき、循環経路内の電力発生抑制物質の量を低減できることになる。このため、極めて簡単な構成をもって、電力発生抑制物質に起因して出力が低下することを抑制できることになる。

【0012】請求項5に記載された発明によれば、循環経路に、電力発生状態が所定状態のとき第1、第2ガスのうちの少なくとも一方のガスを補充するガス補充装置が備えられていることから、大気開放弁が開弁されても、ガスが補充されて循環経路内のガス圧等が一定に維持されることになり、大気開放弁の開弁に伴い、出力が一時的に低下することを抑制できることになる。

【0013】請求項6に記載された発明によれば、除去手段が、電力発生状態が所定状態のとき電力発生抑制物

質を吸着する吸着手段であることから、閉サイクルをなす循環経路の下で使用できることになり、電力発生抑制物質の除去作業に伴い、ガスを循環経路内から捨てることを防止できることになる。

【0014】請求項7に記載された発明によれば、吸着手段が、循環経路に対して、該循環経路に付設されるバイパス通路を介して設けられ、該バイパス通路に、電力発生状態が所定状態のときに吸着手段への流れに切換える切換弁が設けられていることから、具体的構成をもって、前記請求項6と同様の作用効果を得ることができることになる。

【0015】請求項8に記載された発明によれば、除去手段として、電力発生状態が所定状態のとき循環経路内を大気に開放する大気開放弁と、電力発生状態が所定状態のとき電力発生抑制物質を吸着する吸着手段とが備えられていると共に、循環経路に、電力発生状態が所定状態のとき第1、第2ガスのうちの少なくとも一方のガスを補充するガス補充装置が備えられていることから、前記請求項4～6と同様の作用効果を同時に得ることができることになる。

【0016】請求項9に記載された発明によれば、第1、第2ガスのうちの一方のガスが水素であり、第1、第2ガスのうちの他方のガスが酸素含有ガスであり、セルに対して、循環経路をもって水素のみが循環供給されることから、燃料電池として最も一般的な基本的構成のものであつても、前記請求項1と同様の作用効果を得ることができることになる。

【0017】請求項10に記載された発明によれば、除去手段が、電力発生状態が所定状態のとき電力発生抑制物質を吸着する吸着手段であり、該吸着手段がパラジウム薄膜により構成されていることから、燃料ガスとして水素を用いる燃料電池として最も一般的な基本的構成のものにおいて、吸着手段（パラジウム薄膜）は、水素以外の電力発生抑制物質を吸着し、水素を通過させることになり、電力発生抑制物質を除去するに際して、水素を捨てることなく有効に使用できることになる。

【0018】請求項11に記載された発明によれば、セルが、1以上のセルをもって構成されていることから、単一のセルの場合は勿論、複数のセルを集合させた燃料電池スタックに対しても前記請求項1～10と同様の作用効果を得ることができることになる。

【0019】

【発明の実施の形態】以下、本発明の実施形態について図面に基づいて説明する。図1において、符号1は、実施形態に係る燃料電池装置を示すもので、この燃料電池装置1は、燃料電池スタック2を4つ備えている。各燃料電池スタック2は、図2に示すように、複数の固体高分子燃料電池（以下、セルと称す）3を積層して構成されており、その各セル3は、高分子電解質膜4を一對の電極5、6で挟持し、その各電極5、6の外側面に画成

部材7と協働してガス通路8、9をそれぞれ形成することになっている。そして、一方のガス通路8に第1ガスとしての水素（燃料ガス）が供給され、他方のガス通路9に、水素と電気化学反応を起こす第2ガスとしての空気（酸化ガス）が供給されることになっている。

【0020】前記各燃料電池スタック2には、図1に示すように、水素給排系10が関係づけられ、その水素給排系10と各燃料電池スタック2とは循環経路を構成している。この水素給排系10は、各燃料電池スタック2との関連づけのために水素共通供給管11と水素共通排出管12とを備えており、その水素共通供給管11と水素共通排出管12とは、水素共通排出管12から水素共通供給管11への流れのみ許容する逆止弁13を介して接続されている。

【0021】水素共通供給管11は、水素供給口14と供給分岐管15a～15dとを備えている。水素供給口14は、その一端が、逆止弁13の下流側において水素共通供給管11に接続され、その他端には、水素が充填されている水素ガスボンベ45が接続されている。この水素供給口14にはレギュレータ21が介装されており、このレギュレータ21は、水素給排系10内（水素共通供給管11内及び水素共通排出管12内）の圧力を所定圧に保つ役割を有し、水素給排系10内が所定圧以下になったときには開弁して、水素ガスボンベ45内の水素を水素共通供給管11内に補充することになっている。供給分岐管15a～15dは、前記燃料電池スタック2に対応しており、その各供給分岐管15a～15dによって、水素が各燃料電池スタック2における各セル3の一方のガス通路8に供給されることになっている。

【0022】一方、水素共通排出管12は、その一端側において、4つの排出分岐管17a～17dが備えられ、その他端側において、前記逆止弁13に向かって順に、水素循環ポンプ20、パージバルブ41、三方弁42が備えられている。4つの排出分岐管17a～17dは、前記各燃料電池スタック2に対応しており、その各排出分岐管17a～17dによって、各燃料電池スタック2における各セル3の一方のガス通路8内の水素が排出されることになっている。この場合、各燃料電池スタック2における各セル3の一方のガス通路8に対する供給又は各セル3の一方のガス通路からの排出は、各燃料電池スタック2内部のそれぞれの共通通路（図示略）を介して供給又は排出されるが、その内容は、既知であるので、これ以上の説明は省略する。水素循環ポンプ20は、水素を強制循環するもので、これにより、加圧状態の水素が各燃料電池スタック2に向けて供給できることになっている。パージバルブ41は、通常は閉弁状態とされている一方、開弁時には、水素給排系10内と大気とを連通して、水素給排系10内のガスを放出する機能を有している。三方弁42は、前記水素共通排出管12において、その第1の接続口がパージバルブ41側に

接続されると共にその第2の接続口が逆止弁13側に接続され、その第3の接続口は、前記水素供給口14に前記レギュレータ21よりも上流側において接続されるバイパス管43に接続されている。この三方弁42は、その切換えによって選択的に、パージバルブ41側と逆止弁13側、又はパージバルブ41側とバイパス管43側とを連通させることができることになっており、水素は、逆止弁13を介して水素共通供給管11に流れることができるだけでなく、バイパス管43にも流れることができることになっている。この場合、バイパス管43には、吸着手段としてのパラジウム薄膜装置19、逆止弁46が、水素供給口14に向かって順に、介装されている。パラジウム薄膜装置19は、パラジウム薄膜から構成されて、ガスから水素以外の不純物（例えば窒素、二酸化炭素、一酸化炭素、埃等）を除去して水素のみを通過させる機能を有しており、逆止弁46は、パラジウム薄膜装置19を通過した水素が水素供給口14に流れ込むことを許容する一方、水素ガスボンベ45からの水素がパラジウム薄膜装置19側に流れ込むことを阻止する機能を有している。

【0023】前記各燃料電池スタック2には、図1に示すように、空気給排系22が関係づけられており、その空気給排系22は、各燃料電池スタック2との関連づけのために空気共通供給管23と空気共通排出管24とを備えている。空気共通供給管23においては、その一端が空気を取り入れる空気供給口25とされ、その空気共通供給管23には、空気供給口25から空気共通供給管23の他端側に向けて順に、冷却器26、圧縮機（回転ポンプ）27が介装されている。冷却器26は、各燃料電池スタック2に供給する空気の温度を調整するものである。圧縮機27は、その回転数を調整することにより、外気を吸引して各燃料電池スタック2へその空気を供給すると共にその供給空気の圧力等を調整して各燃料電池スタック2における電気化学反応を調整するものであり、その調整は、要求電力により応じて行われることになっている（図5参照）。この空気共通供給管23の他端側には4つの供給分岐管28a～28dが備えられている。この4つの供給分岐管28a～28dは、前記各燃料電池スタック2に対応しており、その各供給分岐管28a～28dによって、空気が各燃料電池スタック2における各セル3の他方のガス通路9に供給されることになっている。

【0024】一方、空気共通排出管24は、その一端が大気に開口する空気排出口30とされる一方、その空気共通排出管24の他端側には4つの排出分岐管31a～31dを備えている。4つの排出分岐管31a～31dは、前記各燃料電池スタック2に対応しており、その各排出分岐管31a～31dによって、各燃料電池スタック2における各セル3の他方のガス通路9から空気が排出されることになっている。この場合も、各燃料電池ス

タック2における各セル3の他方のガス通路9に対する供給又は各セル3の他方のガス通路9からの排出は、各燃料電池スタック2内部のそれぞれの共通通路（図示略）を介して供給又は排出されるが、その内容は既知であるので、これ以上の説明は省略する。

【0025】前記各燃料電池スタック2には、図1に示すように、冷却系32が関係づけられている。冷却系32は、各燃料電池スタック2と協働して冷却水を循環させる循環経路33を構成しており、その循環経路33には、冷却水ヒータ40、循環ポンプ34、冷却水バルブ35、冷却器36を備えられている。また、冷却系32には、冷却器36をバイパスするバイパス経路37が設けられ、そのバイパス経路37に冷却水バイパスバルブ38が設けられている。これにより、これら要素33～38、40をもって冷却水の温度調整を行うことにより、各燃料電池スタック2の温度調整が行えることになっている。

【0026】前記水素給排系10は、本実施形態においては、図1、図3に示すように、制御手段としての制御ユニットUにより制御されることになっている。制御ユニットUには、各燃料電池スタック2の電圧を測定する電圧センサV1～V4からの電圧信号、水素給排系10内の水素濃度を検出する水素濃度検出センサ44からの水素濃度信号、その他各種センサESからの種々の信号が入力されており、制御ユニットUからは、前記バージバルブ41、前記三方弁42に対して制御信号が出力されることになっている。

【0027】この制御ユニットUは、概略的には、次のような制御を行う。すなわち、水素以外の不純物が水素給排系10内に蓄積され、或いは電極5に付着されると、各燃料電池スタック2（セル3）の出力性能が時間と共に低下してくることに鑑み、原則として、一定時間毎（例えば a 分毎（ $0 < a$ ））に水素給排系10内のガス（水素他不純物）を所定時間（例えば α 秒（ $0 < \alpha \ll a$ ））だけ大気に放出（以下、バージと称す）しつつ、その放出して不足する水素を水素給排系10内に補充する一方、その一定時間内でも、各燃料電池スタック2の電圧が所定状態から低下した場合、或いは水素給排系10内の水素濃度が所定状態から低下した場合には、水素給排系10内に水素以外の不純物が蓄積されているとして、バージを行おうとしている。しかも、バージに伴う水素の補充においては、水素給排系10内の残存水素の回収を図り、その水素をも補充水素に使うことにより、水素使用量の低減を図ろうとしている。

【0028】次に、上記制御内容を、図4に示すフローチャートに基づき説明する。尚、Sはステップを示す。先ず、S1において、各燃料電池スタック2からの電圧、水素濃度検出センサ44からの水素給排系10内の水素濃度等の各種データが入力され、次のS2において、タイマによりカウントが加算される。そして、次の

S3において、経過時間Tが、タイマがカウントを開始してから一定時間T10が経過したか否かが判別される。これは、原則として、一定時間毎にバージを行い、電力発生抑制物質としての不純物を水素給排系10（循環経路）内から放出する判断を得るために行われる。

【0029】上記S3の判別がYESのときには、タイマがリセットされると共に、バージバルブ41が開（大気開放）とされ、所定時間だけバージが行われて、水素給排系10内の不純物が大気に放出される（S4、S5）。またこのとき、三方弁42が、バージバルブ41に同期して、バージバルブ41側を、逆止弁13側ではなくバイパス管43側に連通させるように切換えられることになり、これにより、バージバルブ41を通過して三方弁42に至ったガス（水素等）は、このとき、水素給排系10内の圧力がバージに伴って低下していることに基づきレギュレータ21を介して水素共通供給管11内に流入しているフレッシュな水素（水素ガスボンベ45からの水素）に吸引されて、該フレッシュな水素と共に水素共通供給管11内に流れ込むことになる。この場合、バイパス管43に流れ込むガスは、パラジウム薄膜装置19に通ることになり、そのパラジウム薄膜装置19により不純物が除去された水素が、再び補充水素として水素共通供給管11内に供給されることになる。このため、フレッシュな水素と、バイパス管43からの回収された水素とによって、バージ実行中においても、水素給排系10を含む循環経路内の圧力を一定に保って出力の低下を抑制することができただけでなく、回収された水素の再利用により、水素の使用量をできるだけ減らすことができることになる。そしてこの後、バージの終了に伴い、三方弁42は、元の状態に切換えられ、水素給排系10は、元の閉サイクルの状態に戻ることになる。

【0030】前記S3がNOのとき、すなわち、前回のバージから一定時間T10が経過していないときには、S7において、各燃料電池スタック2の電流が一定か否かが判別される。これは、出力性能の低下があるか否かを定常状態の下で判別して、判別の信頼性を高いものにするためである。このS7がNOのときには、バージバルブ41が閉弁状態とされる一方、S7がYESのときには、各燃料電池スタック2の電圧が所定状態から低下しているか否か、水素給排系10内の水素濃度が電圧が所定状態から低下しているか（不純物濃度が相対的に増大しているか）否かが判別される（S9、S10）。水素給排系10内に不純物が蓄積され、或いは電極5に不純物が付着しているか否かを判別してバージする必要があるか否かの判断を得るためである。

【0031】前記S9、S10のいずれもがNOのときには、前記S8に移行する一方、前記S9又はS10のいずれかがYESのときには、S11において、経過時間Tが前回のタイマカウント開始から一定時間T10未満の所定時間T20よりも大きいかが判別される。

前回のバージからあまりにも短い時間しか経過していない場合を、燃料電池スタック2の異常として判定するためである。S11がNOのときには、S12において該当燃料電池スタック2が異常であると判定され、S11がYESのときには、前記S4に進んで前述の如きバージ等が行われる(S5、S6)。

【0032】したがって、この実施形態においては、バージが、原則として、一定時間T10経過毎に行われるだけでなく、経過時間Tが一定時間T10以下であっても、各燃料電池スタック2における電圧低下或いは水素給排系10内の水素濃度の低下を検出して、バージを行うこととなり、水素給排系10を含む循環経路内に不純物が蓄積されることを抑制できることになる。このため、循環経路内に蓄積される不純物に基づき、出力性能が低下することを抑制できることになる。

【0033】以上実施形態について説明したが本発明においては、次のようなものを包含する。

(1) レギュレータ21に代えて電磁弁を設け、その電磁弁を制御ユニットUにより開閉制御すること。

(2) 水素だけでなく、第2ガスとしての酸化ガスをも、燃料電池スタック2に対して循環供給すること。

(3) 水素ガスポンプ45に代えて、改質器、例えばメタノールをもって水素を生成する改質器を用いること。

(4) 当該燃料電池装置を、車両等の動力源として用いること。

(5) S8でバージバルブ41を閉じた後も、三方弁42に至ったガスの一部をパラジウム薄膜装置19に供給すること。

【0034】尚、本発明の目的は、明記されたものに限らず、実質的に好ましい或は利点として記載されたものに対応したものを提供することをも暗黙的に含むものである。

【図面の簡単な説明】

【図1】実施形態に係る全体系統図。

【図2】セル（燃料電池）構造を概念的に示す説明図。

【図3】制御ユニットに対する入・出力関係を示す図。

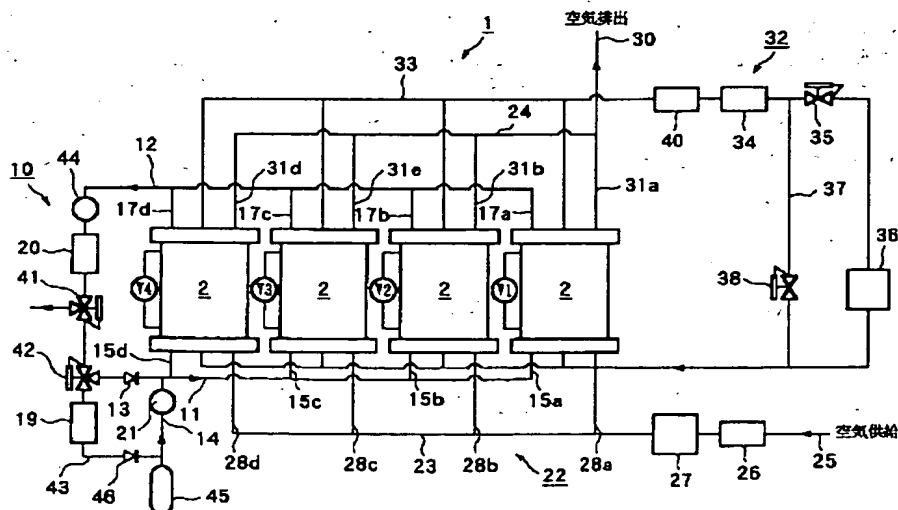
【図4】制御ユニットUによる制御例を示すフローチャート。

【図5】要求電力に対する圧縮機の回転数の特性を示す図。

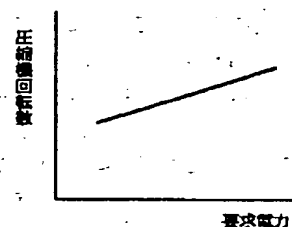
【符号の説明】

- 1 燃料電池装置
- 2 燃料電池スタック
- 3 セル
- 10 水素給排系
- 19 パラジウム薄膜装置
- 41 バージバルブ
- 42 三方弁
- 44 水素濃度検出センサ
- 45 水素ガスポンプ
- U 制御ユニット
- V1 電圧センサ
- V2 電圧センサ
- V3 電圧センサ
- V4 電圧センサ

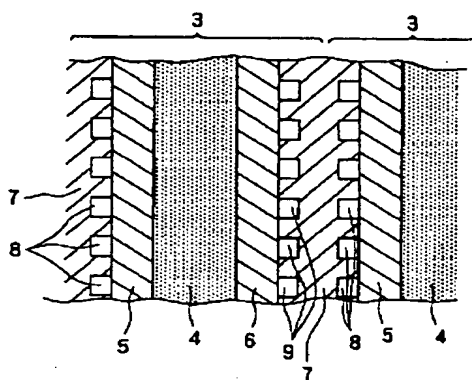
【図1】



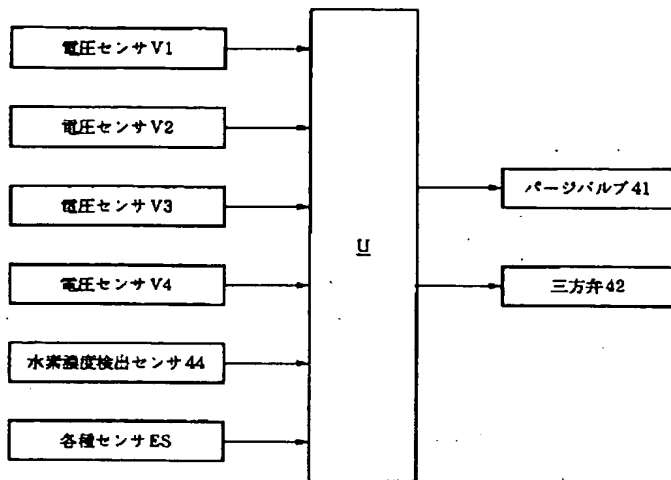
【図5】



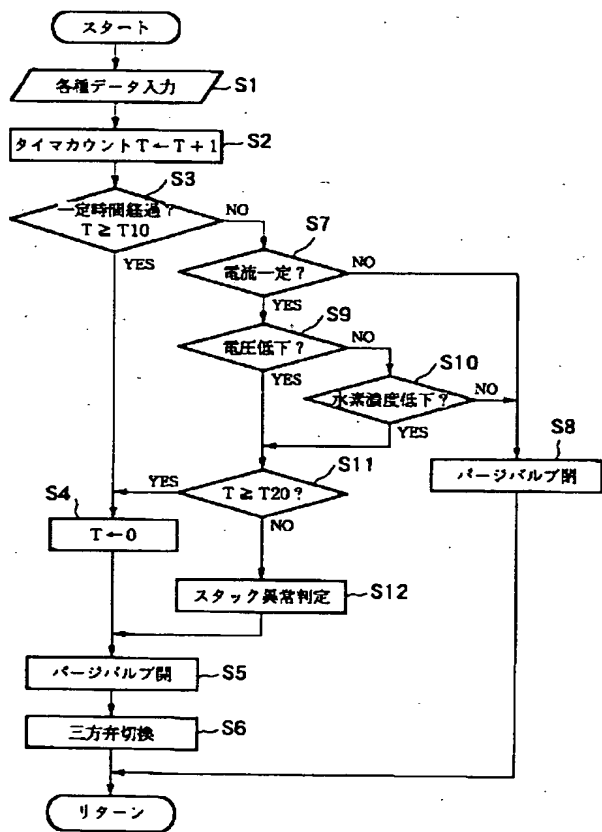
【図2】



【図3】



【図4】



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